

Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

1. (Previously Presented) A method of backwashing a membrane filtration system including a vessel, a membrane module, piping, and a manifold comprising:
 - filtering a feed liquid through pores in walls of membranes of the membrane filtration system to produce a liquid permeate;
 - withdrawing the permeate from lumens of the membranes and through the manifold, a portion of the piping, and a valve while filtering the feed liquid;
 - stopping the filtration process;
 - isolating the lumens of the membranes, the manifold, the portion of the piping, and a gas inlet when the filtration process is stopped, the lumens of the membranes, the manifold, and the portion of piping upstream of the valve during filtration, wherein the lumens of the membranes, the manifold, and the portion of piping consist of those through which permeate is withdrawn while filtering the feed liquid;
 - scouring surfaces of the membranes by flowing bubbles of a first gas past surfaces of the membranes;
 - supplying a second gas through a second gas inlet at a pressure less than a bubble point of the membranes;
 - applying the second gas to a portion of liquid permeate present in the isolated lumens, manifold, and portion of piping by introducing the second gas through the second gas inlet into the filtration system on a side of the valve in direct fluid communication with the membrane module;
 - directing the portion of liquid permeate into the membrane module through a first end of the membrane module and through a second end of the membrane module;
 - backwashing the membranes by displacing at least some of the portion of liquid permeate through pores in walls of the membranes, the second gas not penetrating into the membrane pores;

discharging backwash waste from the vessel;
refilling the vessel with feed liquid;
venting the second gas from the isolated lumens, manifold, and portion of piping;
and
resuming filtration.

2-3. (Canceled)

4. (Previously Presented) A method of filtering solids from a liquid suspension comprising:

immersing filtration membranes in the liquid suspension;
filtering the liquid suspension through pores in walls of the filtration membranes;
producing a liquid permeate within lumens of the filtration membranes;
drawing off liquid permeate from the lumens;
withdrawing the permeate from the lumens and through a manifold and a valve;
periodically suspending the filtration process;
isolating the lumens, the manifold, a gas inlet, and a portion of piping when the filtration process is suspended, the lumens, the manifold, and the portion of piping upstream of the valve during filtration, wherein the lumens, the manifold, and the portion of piping consist of those through which permeate is withdrawn;
directing liquid permeate present in the isolated manifold and portion of piping into the lumens through a first end of the filtration membranes and through a second end of the filtration membranes; and
applying a gas at a pressure below a bubble point of the filtration membranes to the liquid permeate to displace at least some of the liquid permeate through the pores in the walls of the filtration membranes in a direction opposite to that of filtration, the gas not penetrating into the membrane pores.

5. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 4 wherein displacing at least some of the liquid permeate through the

pores in the walls of the filtration membranes comprises removing solids from the filtration membranes into the liquid suspension surrounding the filtration membranes.

6. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 5 further comprising reducing the volume of the liquid suspension surrounding the filtration membranes before displacing at least some of the liquid permeate through the pores in the walls of the filtration membranes.

7. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 6 wherein the volume of liquid suspension surrounding the filtration membranes is reduced by suspending provision of the liquid suspension while providing a pressure differential across walls of the filtration membranes and drawing permeate from the filtration membranes.

8. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 5 further comprising removing at least part of the liquid suspension surrounding the filtration membranes containing the removed solids by a sweep, drain-down or by a feed and bleed process to at least partially discharge the liquid suspension surrounding the filtration membranes.

9. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 4 further comprising using permeate remaining in ancillaries such as headers, and piping in addition to that in the filtration membrane lumens and manifold as a source of backwash liquid.

10. (Previously Presented) A method of filtering solids from a liquid suspension comprising:

- applying the liquid suspension to lumens of filtration membranes;
- filtering the liquid suspension through pores in walls of the filtration membranes;
- forming liquid permeate on a shell side of a pressure vessel in which the filtration membranes are mounted;

drawing off liquid permeate from the shell side of the pressure vessel;

periodically suspending the filtration process; and

applying a gas at a pressure below a bubble point of the filtration membranes to liquid permeate remaining within the shell side of the pressure vessel, the liquid permeate remaining within the shell side of the pressure vessel consisting of the liquid permeate formed on the shell side of the pressure vessel, to displace at least some of the liquid permeate through the filtration membrane pores in a direction opposite to that of filtration, the gas not penetrating into the membrane pores.

11. (Previously Presented) The method of filtering solids from a liquid suspension according to claim 4 further comprising increasing the amount of permeate available for backwashing when filtration is suspended by providing a further chamber or reservoir in a permeate flow circuit.

12. (Canceled)

13. (Withdrawn) A filtration system for removing fine solids from a liquid suspension comprising:

(i) a vessel for containing said liquid suspension;

(ii) a plurality of permeable, hollow membranes within the vessel;

(iii) means for providing a pressure differential across walls of said membranes such that some of the liquid suspension passes through the walls of the membranes to be drawn off as permeate;

(iv) means for withdrawing permeate from the membranes; and

(v) means for applying gas at a pressure below the bubble point to the liquid permeate within the system and the membrane lumens to affect a discharge of at least some of the liquid permeate in the lumens through the membrane walls to dislodge any solids retained therein and displace the removed solids into the liquid suspension surrounding the membranes.

14. (Withdrawn) A filtration system according to claim 13 wherein said membranes are mounted in a number of membrane modules and the membrane modules are used in a bank and connected to a manifold for distributing liquid suspension to and removing permeate from the system.

15. (Withdrawn) A filtration system according to claim 14 wherein the gas is introduced into the manifold of the bank of modules so that permeate within the manifold is utilized for backwash.

16. (Withdrawn) A filtration system according to claim 13 further including means to reduce the volume of liquid suspension in the vessel before the backwash so as to reduce the backwash waste volume.

17. (Withdrawn) A filtration system according to claim 16 wherein the volume of liquid suspension in the vessel is reduced by suspending flow of feed to the feed vessel while continuing to provide a pressure differential across walls of said membranes and withdrawal of permeate from the membranes.

18. (Withdrawn) A filtration system according to claim 17 wherein the pressure differential across walls of said membranes is obtained by application of a pressurized gas.

19-23. (Canceled)

24. (Previously Presented) The method according to claim 1, wherein the permeate remaining present in the system when the filtration process is stopped consists of permeate present in the system on a side of a valve configured and arranged to isolate the filtration membranes from a second section of piping.

25. (Previously Presented) The method according to claim 1, wherein isolating the membrane lumens, the manifold, and the gas inlet comprises closing the valve, the valve configured and arranged to isolate the membranes from a second section of piping.

26. (Previously Presented) The method according to claim 1, wherein backwashing is performed without the use of a backwash pump or a permeate holding tank.

27. (Previously Presented) The method according to claim 1, wherein the permeate remaining present in the system when the filtration process is stopped consists of at least one of permeate remaining in at least one manifold in fluid communication with at least one membrane module, in at least one membrane module header, in piping associated with the at least one manifold and the at least one membrane module header, and in a permeate side of filtration membranes

28. (Previously Presented) The method according to claim 1, further comprising draining down liquid suspension including the displaced backwashing liquid.

29. (Canceled)